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PREFACE

This section provides some key information for new users of this guidebook:

An overview of the content and structure of the document

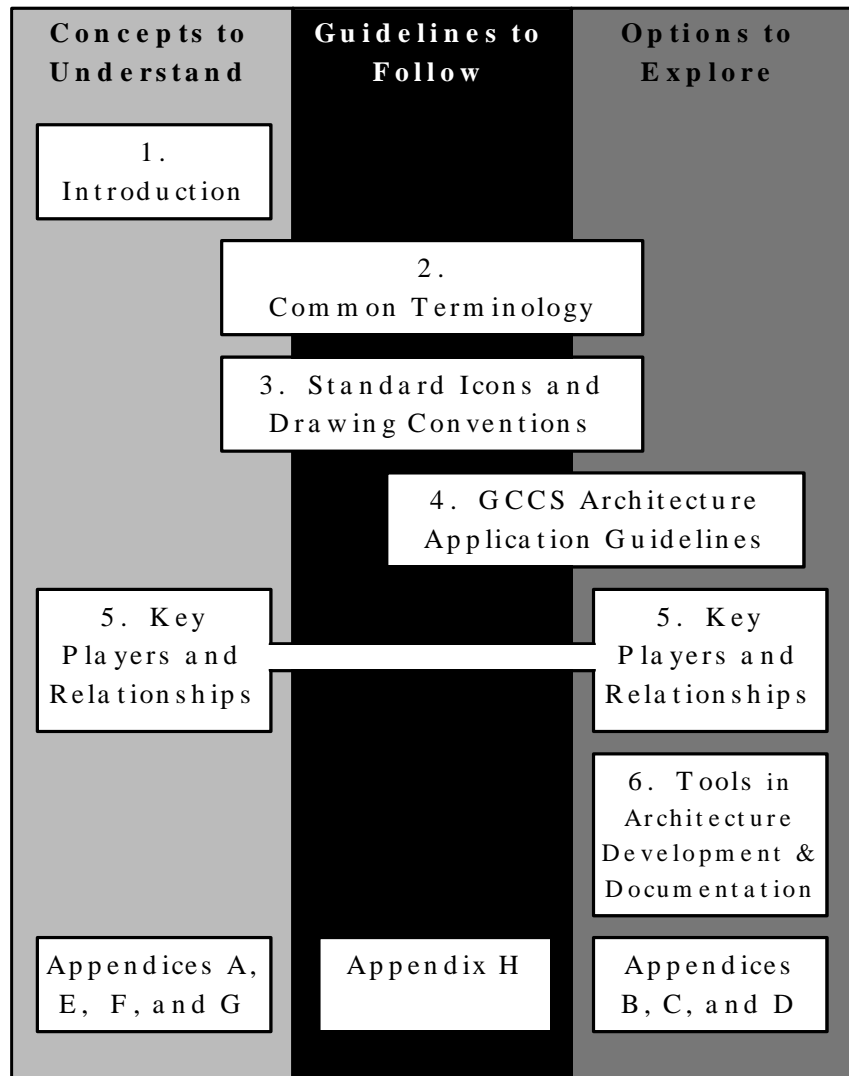
A description of page layout conventions, navigation aids, and other information presentation features designed to help you find the information you need, both within and beyond this guidebook.

CONTENT AND STRUCTURE OVERVIEW

This document addresses the Global Command and Control System (GCCS) architecture methodology and conventions from several different perspectives. The core of the document is a set of guidelines to follow when developing GCCS architecture depictions. These guidelines provide a common language – both verbal and graphic – for use by all GCCS developers, contributors, users, and maintainers. Around these core guidelines are two additional kinds of information that lend meaning to the definitions and conventions and explain how to adapt them to a tailored, real-world architecture application. The illustration on the next page shows how the sections of this document span across the three information perspectives: guidelines, concepts, and options.

Section 1, Introduction, provides the very basic information needed to understand the rest of this document. It identifies several types of users and discusses how each one might approach both architecture work and architecture guidance from different angles.

Section 2, Common Terminology, defines many types of architectures that are applicable to documenting GCCS sites and supporting the managerial and technical aspects of system implementation. This section also introduces terminology related to architecture drawings and defines the major technological elements included in these drawings.



Content Plan of This Document

Section 3, Standard Icons and Drawing Conventions, expands the common GCCS “language” to include graphic elements. This section presents a basic set of standard icons and provides a standard framework for organizing architecture elements on a page or workstation screen.

Section 4, Architecture Application Guidelines, suggests ways the common language established in Sections 2 and 3 can be applied and adapted. It includes guidelines for managing, updating, and approving architecture drawings.

Section 5, Key Players and Relationships, defines the roles of various types of people that contribute to, or use the output of, the GCCS architecture process. This section is a point of departure: none of the roles and relationships it describes are set in stone. The intent is not to tell individuals in each of these categories what they should be doing; rather, this section aims to give an individual at one of these levels an insight into the parts played by people both above and below and some tips on fostering productive relationships.

Section 6, Tools in Architecture Development and Documentation, focuses on automated tools that speed up architecture work and improve the results. This section addresses the tools generically; reports on specific products are included in Appendix C.

Appendix A addresses the growth of the practice of architecture development, and how the GCCS architecture evolved. Appendix B provides instructions for accessing GCCS information on the World Wide Web (WWW). Appendix C contains tool evaluation reports from a limited study conducted in June/July 1995. Supporting tool information, including an overview of a wide range of software products, appears in Appendix D. Appendix E provides an annotated bibliography pointing the way to a number of helpful references. A list of acronyms appears in Appendix F. Points of contact within the GCCS architecture community are identified in Appendix G. Appendix H provides detailed instructions for submitting materials to the GCCS Architect.

PAGE LAYOUT CONVENTIONS AND USABILITY AIDS

The purpose of this document is twofold. First, it is intended to introduce the reader to the architecture methodology and conventions selected for GCCS. After the reader has reviewed the guidebook to develop a basic understanding of the topic, it is designed to serve as a handy reference that provides information and tips helpful to the user engaged in developing, reviewing, managing, or applying GCCS architectures. The format and layout of the document have been designed to support these two uses.

Specific usability aids include:

- A brief statement of the contents of each section, appearing in italics at the beginning of the section.
- “Boxnotes” – recognizable by gray shading and icons in the margin. These notes provide pointers to more information or highlight key concepts. Icons in the margin will help you recognize each type of note, as in the following examples.



Boxnotes with question marks are intended to help the reader who needs a more detailed explanation of concepts than can be accommodated here. These notes point to other reference documents that address critical topics at length.



Boxnotes with exclamation points highlight mandatory policy guidance, critical things to remember, or common pitfalls.



Boxnotes marked with the compass will help you find your way around this document. These notes refer you to related topics in other sections. To keep the document relatively uncluttered, pointers to the list of acronyms, reference list, and points of contacts list are not provided in the text.



Boxnotes with a key in the margin summarize key technical points to be gleaned from each section. These notes may also highlight important nontechnical concepts, such as suggested ways of applying the guidance provided in the document.

cont'd.

A boxnote with this notation in the margin is a continuation of a note begun on a previous page.

In addition to the usability aids provided in the text, the appendices provide several different kinds of information that enable the reader to better understand this document, and to move beyond it to related materials. Additional appendices may be added as the GCCS architecture and the system evolve, as personnel change, and as new products, approaches, and opportunities arise.

RELATIONSHIP BETWEEN THIS DOCUMENT AND OTHERS

This guidebook represents an attempt to focus on the specific architectural needs of GCCS by making architecture systems easy to use and to understand by many levels of the GCCS community. In the process, some effort has been dedicated to broader architectural issues that may be more fully addressed in other sources by other organizations. It is not the purpose of this document to replace ongoing architecture-related initiatives or to usurp the roles of other organizations that may have architectural responsibilities. This document introduces concepts such as geomorphic layout, thematic layering, and a methodology for the use of icons that could be applied to many other areas of DoD activity. It is hoped that other organizations will take advantage of these concepts where possible.

YOUR COMMENTS ARE WELCOME

Comments on the applicability of this guidebook, suggestions for enhancement, and strategies, tools, or conventions that other users can build upon are welcome. Please send them to the GCCS Architect at the address listed in Appendix H.

1. INTRODUCTION

This section provides:

The purpose of this document

Its scope

Suggested ways in which different types of users can apply the information contained in this document.

BEGINNING WITH THE BASICS

The Global Command and Control System (GCCS) is “a highly mobile, deployable command and control system that will support forces for joint and combined operations throughout the spectrum of conflict, anytime and anywhere in the world, with compatible, interoperable, and integrated C4I systems.”¹ GCCS is focused on the needs of the warfighter: it is intended to supply the command, control, communications, computers and intelligence (C4I) tools the warfighter needs to accomplish missions around the globe.

GCCS is not being developed as a monolithic system that will emerge full-grown at some point in the future and sweep away all existing systems. Instead, GCCS is following an evolutionary path. Some existing systems -- the “best of breed” -- are being migrated toward GCCS. Other legacy systems are going to remain operational until their functionality can be supported by GCCS and some additional capabilities are being defined and developed. An architecture is needed to manage the integration of system elements that will evolve over time, and will eventually span across all the military Services and provide C4I functionality throughout all levels of command.

¹ Joint Staff, Draft GCCS Concept of Operations, February 1994

What is an architecture? At the most general level, an architecture is a conceptual structure, a framework of ideas having a spatial relationship. An organizational chart, the construction plans for a building, and the diagram of the contents of this guidebook that appears in the Preface all meet this definition. Architectures provide a conceptual structure for systems ranging from the very small, such as the layout of components on a microchip, to the very large, such as the layout of a phone company's telecommunications grid across a region or around the world. In the context of information technology, architecture has been defined as "the structure given to information, applications, and organizational and technological means," which addresses "the groupings of components, their interrelationships, the principles and guidelines governing their design, and their evolution over time."³

Although the term "GCCS architecture" is commonly used in this and other documents, there is no single GCCS architecture depiction that can be looked at in isolation and taken to represent the whole of GCCS. Planners and policy-makers in the Joint Staff and at the Defense Information Systems Agency (DISA) have drawn up the high-level strategic framework for GCCS, starting with the C4I for the Warrior concept, and they continue to develop certain types of architectures to reflect key development guidelines, such as the common processing environment established for GCCS. The GCCS Engineer uses different types of architecture depictions to show system-wide connectivity, the typical configuration of servers and workstations, and other views. At each GCCS site, local planners and engineers must create detailed architecture depictions to portray local GCCS implementation and to show connectivity with legacy systems and site-specific information technology assets. The "GCCS architecture," in the broadest sense, comprises all of the frameworks and depictions developed at all of these levels.



Still uncertain about what architecture is and why it is important? Check out the following for a more detailed discussion:

- **Technical Architecture Framework for Information Management, Volume 4: Standards-Based Architecture Planning Guide, Section 1 (Version 2.0 June 1994)**
- **The Office of the Assistant Secretary of Defense for C3I's DoD Architectures Review, Draft Technical Report, January 1995 – Abridged (Volume 1) or Unabridged (Volume 2)**
- **The article "The Art of Systems Architecting," by Eberhardt Rechtin, in IEEE Spectrum, October 1992.**

Don't be surprised to discover that these authors' definitions of architecture differ subtly from one another and from that

³ Defense Information Systems Agency, TAFIM Version 2.0, Volume 4 June 1994

provided here. Because the term is so broad and can be applied in many different contexts, it can assume different shades of meaning depending on who is using it. The Defense Information Systems Agency has an analysis effort underway to study the various uses of the term and, if possible, standardize it. Preliminary findings are contained in DISA's Draft Architecture Requirements and Definition Report dated June 1995.

Real-World Uses for Architecture

The need to create architectures is not confined to GCCS. Architecture depictions are tools that support a wide range of activities. The methodical approach needed to create these depictions can make operational processes clearer, relationships more apparent, and problems easier to detect. This section discusses some of the ways architecture development can facilitate the work you have to do and support a system throughout its life cycle.

Designing a New System

If you are planning to design a new system or a new arrangement of a group of existing systems, you may well want to create an architecture. An objective architecture (defined in Section 2) can serve as a master plan for the system design. Other architectures provide a consistent means of communicating about the system and of checking to ensure that the design is consistent with technical best practices as well as with the functional requirements for the system. As is the case with all of the uses for architecture described in this section, once a decision to make an architecture has been made, a de facto documentation process for the system has been initiated. This first step, however informal it may be, provides a place to add critical information about the system as it changes and gives system developers and managers a small push toward continuing the documentation process.

Incorporating New System Elements

You have a new system or element to incorporate into an existing system. An architecture will help you depict where the new component should go to show the ramifications of such a decision and to give an overall view of the modified whole.

Planning for Modification of an Existing System

What if I take this from here and move it to there? How about adding more of this element, or using less of that? What if I substitute a similar, but not identical, piece of equipment? For all of these questions, architecture depictions offer a way to explore the possibilities, understand the consequences, and select the best approach to changing a system.

Planning for Installation

What if the installation you plan to make is functionally the same as the system architecture, but the quantities of specific pieces of equipment are different? Again, an architecture will help to answer such a question. Installation can also be supported by adding location drawings, notations of installation phases, or other information to an architecture drawing.

Analyzing Operations

An architecture can be an exceptional aid to the analysis of operations. It can show what element performs what functions, illustrate the information flow, and identify relationships among processes. Specific architectures can be constructed for the varied purposes of analysis, each tracking equipment performance, or specific processes, or other variables.

Training Users

The need to train is constant. Architecture depictions can be used in this process. All system users need reference material, and good architectural drawings make great training aids.

Accomplishing Support

Decisions on periodic maintenance, staffing levels, changes in operational manning in response to contingencies and the like can be assisted by good architectural drawings. When used in a maintenance plan, such drawings help quantify costs and speed action to the portions of a system in greatest need.

Developing Briefings

Briefings are the bane of modern organizational life. We all have to communicate to someone about some aspect of our system. Architectural drawings have always been used for this. Some drawings used in briefings become famous and are requested again and again by decision makers at all levels in the organization. By making architectures in a manner consistent with the methods and conventions in this document you can provide a permanent foundation for the briefing process. Further, as ideas and circumstances change, the methods and conventions shown herein allow you to highlight the changes in a consistent manner.

Oversimplifying the Facts and Complicating the Process

It's true: in addition to all the beneficial uses noted above, architectures can sometimes make things worse instead of better. For example, suppose you create a drawing to support the integration of a number of diverse systems. Your drawing depicts existing "stovepipe" systems and applications, giving the appearance that integration can be achieved in building-block fashion when in reality special development is necessary to make these systems work together. In supporting documents, you detail all of the constraints and caveats that underlie the seemingly straightforward integration shown on the drawing. But

what happens next? Your neat, easy-to-follow drawing takes on a life of its own and circulates without all of the backup material. Critical information gets lost as subsequent drawings are made by other individuals and as the symbology in your architecture gets imported into other plans without an accurate understanding of its meaning or the supplemental information intended to accompany it. The proper use of architecture conventions as presented in this document helps to ensure accurate presentation of data in the first place, and consistent communication as that data changes hands and endures through time.

THE NEED FOR ARCHITECTURE METHODOLOGY AND CONVENTIONS

For GCCS to develop and work as intended, all the contributions of planners and policy-makers, engineers, program managers, project officers, local site managers, and end users must mesh and make sense when viewed as a whole. For this to happen, these personnel need to use common terminology, standard drawing symbology and conventions, and a shared approach to architecture development and documentation.

A Server is a Server is a Server...

The metaphor of language is very apt for describing the definition of architecture elements supporting GCCS. At the most essential level, language allows people to communicate. Visually, a language may use written words or graphic symbols. To be a viable means of communication, a language must have these features:

- **Consistency.** We cannot call something a printer today and call the same object a plotter tomorrow. Also, when two people use a word, their concept of what that word means should be fundamentally similar, if not identical.
- **Flexibility.** In English and other languages, words are always evolving to describe new inventions and individual perspectives. So it is with both the visual and verbal language of architecture: new information systems capabilities and specialized local configurations drive a constant need to adapt, refine, and reinvent architecture terms and icons.
- **Expediency.** There would be little need for language if it did not facilitate human interaction. Similarly, architecture conventions are only valuable if they save time, enhance clarity, and encourage wider understanding of the systems they represent.

Sections 2 and 3 of this document provide the basic elements of an architecture vocabulary and a system of depiction that will facilitate GCCS-related communication. Each user is free to expand and adapt this basic system. Later sections include tips for doing so while preserving the consistency, flexibility, and expediency of the system as a whole.

Making It Official: The Architecture Management Methodology

As a truly global system, GCCS will affect users at all levels from the Pentagon to the Joint Task Force (JTF). The dispersal and use of architecture data will be equally extensive. There will, however, be major variations in the way GCCS architecture data is viewed, used, and managed. Despite these variations, a standard methodology for accepting, archiving, and revising architectures is needed to ensure accuracy of the data in use and to facilitate proper coordination within the local organization and, where needed, throughout the GCCS hierarchy.

Section 2 introduces the concept of a set of standard architecture drawings. Section 4 expands on the definitions of drawing types, providing a methodology for the management of architecture drawings throughout the life-cycle of each drawing.

THE SCOPE OF THIS GUIDEBOOK

This guidebook was developed by a diverse team: a senior executive who provided the broad brushstrokes of a vision, architecture specialists, engineers of various types, and project management personnel. This diversity reflects the real world in which GCCS and many other systems are conceived, designed, and implemented. Various organizations and individuals are assigned distinct roles, and their levels of technical acumen and programmatic knowledge can vary considerably.

End users, project officers, engineers, program managers, and policy-makers all have essential roles in making GCCS achieve the ambitious goals that have been established for it. Although it is probably impossible to create usable guidance that is “all things for all people,” the authors have attempted to address the needs of each of these players. As illustrated in Figure 1-1, it is hoped that each reader will find a core of critical information, plus some interesting new perspectives.

Assuredly, most readers will also find some material that is too basic or too advanced or simply not germane to their job. It is perfectly fine to skip over some sections, pull the document apart and copy the relevant parts, or adapt it in any other way for individual use. The notes that follow the graphic suggest ways in which different types of users can apply this document.

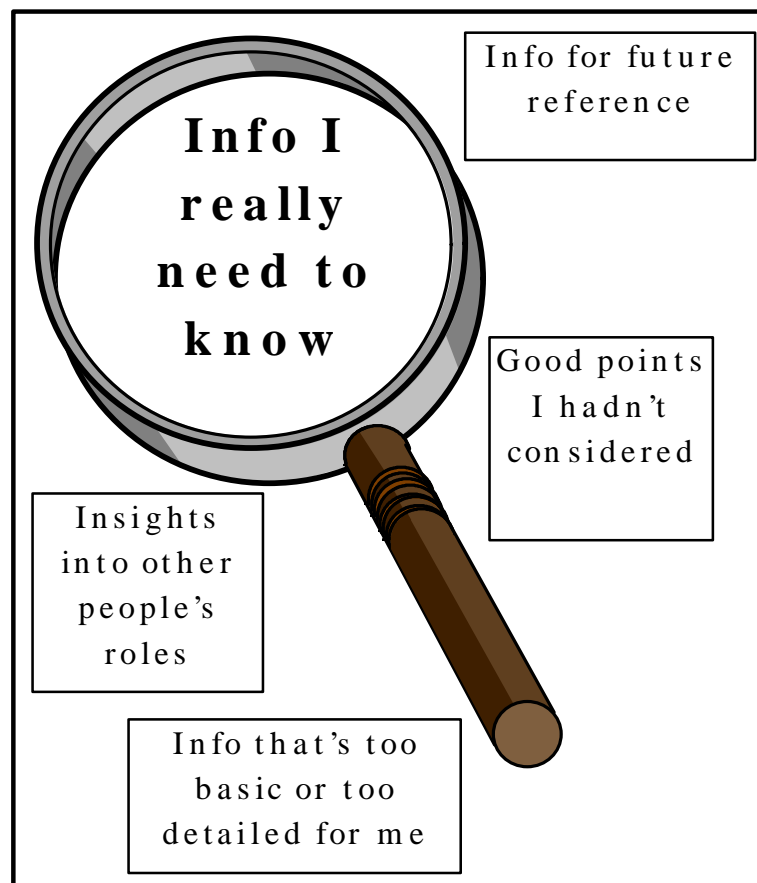
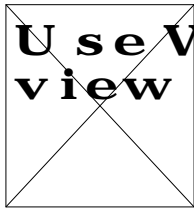


Figure 1-1.
Scope of This Guidebook from the User Perspective



If you are a senior manager or policy-maker, you may want to familiarize yourself with the standard drawing conventions (Section 3) and the procedure for developing and archiving drawings (Section 4) that your staff will use. You may also want to review the various types of architectures defined in Section 2 so that you can solicit information in the format and level of detail most appropriate for your needs. Section 5 can assist you in structuring a productive GCCS project team.

cont'd.

- If you are an **engineer or architect**, most of this document should prove useful to you. Sections 2, 3, and 4 will cover some areas with which you are already familiar, but you should review them carefully to pick up GCCS-specific architecture guidance, as well as options for enhancing your approach to architecture work. Section 5 will help you understand how your responsibilities fit in with those of other people involved in GCCS. Section 6, Appendix C, and Appendix D can help you select tools to automate your work.
- If you are a **project officer** charged with overseeing a part of GCCS implementation at your site, the definition of architecture types in Section 2, especially the specialty architectures that focus on particular aspects of the overall architecture, will be of particular importance to you. You should become familiar with the sequence of drawings and the approval and archival methodology in Section 4. The tools information in Section 6, Appendix C, and Appendix D will help you select tools to manage and document your work.
- If you are an **end user** - a site manager or a GCCS operator - you will want to closely review Sections 2 and 3 to learn how to interpret architecture drawings. Section 4 can help you put architecture data to work for you, and Section 5 will clarify the planned working relationships among developers, implementors, and users of GCCS.

BEYOND GCCS: OTHER DoD ARCHITECTURES

While the scope described above is narrowly focused on GCCS, the concepts presented here can apply to many other areas of architecture. Once you leave the field of GCCS-related architecture, however, you enter the province of architectures that have in some way been referenced by other DoD directives. Figure 1-2 is drawn from the *DoD Architectures Review, Volume I (Abridged)*, and is included here to give you a feeling for just how many references there are.

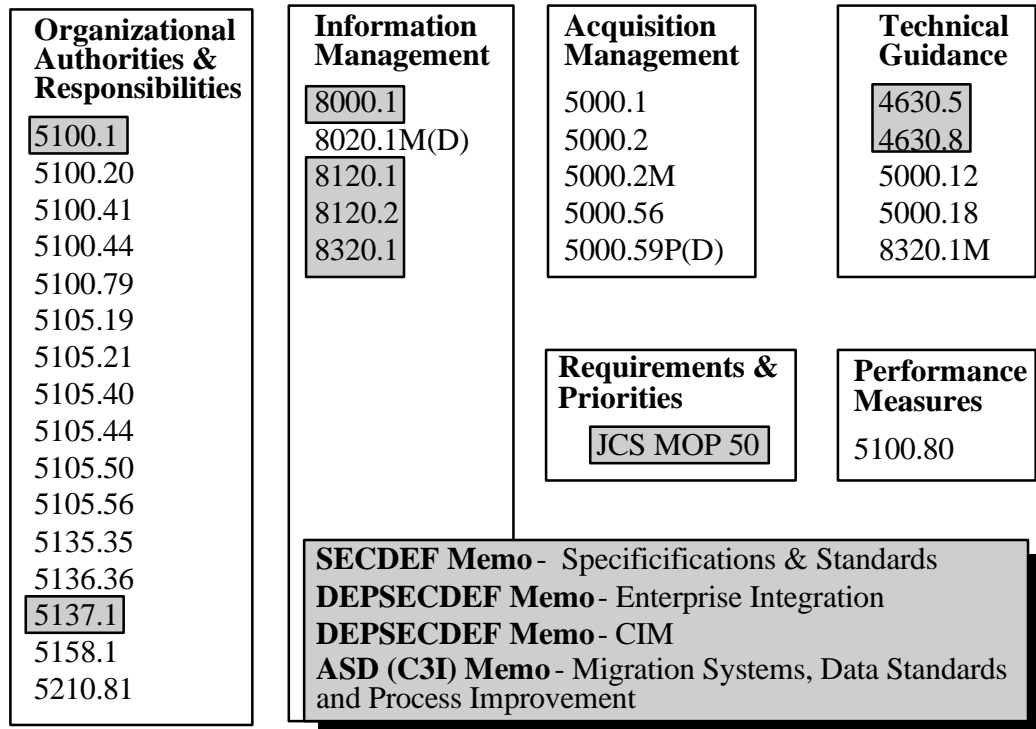


Figure 1-2.
"Directives Landscape" from DoD Architectures Review